

CLAIMS

I claim:

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1. A method of forming a structure on a substrate, the method comprising:

a) depositing a first dielectric layer on the substrate;

b) depositing a second dielectric layer on the first dielectric layer, wherein the first and second dielectric layers comprise materials having dissimilar etching characteristics;

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c) depositing a first mask layer on the second dielectric layer, wherein the first mask layer includes a first via pattern having a predetermined width T;

d) anisotropically etching the first via pattern through the second dielectric layer;

e) removing the first etch mask;

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f) depositing a third dielectric layer on the second dielectric layer, wherein the second and third dielectric layers comprise materials having dissimilar etching characteristics; and

g) depositing a second mask layer on the third dielectric layer, wherein the second mask layer includes a trench pattern overlaying the first via pattern and having a predetermined width P, such that T exceeds P by a predetermined measure M, whereby the first via pattern and the trench pattern are adapted for fabricating a dual damascene structure.

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2. The method of claim 1 further comprising:

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a) anisotropically etching the trench pattern through the third dielectric layer, thereby forming a trench and a second via pattern; and

b) anisotropically etching the second via pattern through the first dielectric layer, thereby forming a via hole extending to the substrate.

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3. The method of claim 2 wherein a cap layer is interposed between the substrate and the first dielectric layer.

4. The method of claim 3 additionally comprising:

- a) anisotropically etching the trench through the second dielectric layer; and
- b) simultaneously anisotropically etching the via hole through the cap layer.

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5. The method of claim 1 wherein the first and third dielectric layers comprise materials having similar etching characteristics.

6. The method of claim 1 wherein M is at least  $0.02\mu$ .

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7. The method of claim 1 wherein the first and third dielectric layers comprise one or more dielectric materials selected from the group consisting of amorphous fluorinated carbon, organic spin-on materials, spin-on glass, aero-gel, poly(arylene) ethers, fluorinated poly(arylene) ethers and divinyl siloxane benzocyclobutane.

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8. The method of claim 7 wherein the second dielectric layer comprises one or more dielectric materials selected from the group consisting of silicon oxides, silicon nitrides and silicon carbides.

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9. The method of claim 1 wherein depositing a first mask layer comprises depositing a mask layer selected from the group consisting of photoresist mask layers, hard mask layers and combinations of photoresist mask layers and hard mask layers.

10. The method of claim 1 wherein the first and third dielectric layers comprise Black Diamond™.

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11. The method of claim 2 additionally comprising simultaneously filling the trench and the via hole with a conductive material, whereby a dual damascene structure is formed.

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12. The method of claim 11 wherein the conductive material comprises one or more materials selected from the group consisting of metals, alloys, metallic superconductors and nonmetallic superconductors.

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13. A method of forming a structure on a substrate, the method comprising:

- a) forming a dielectric stack including an etch stop layer;
- b) forming a sacrificial etch segment in the etch stop layer;
- c) forming a first trench on the etch stop layer;
- d) forming a second trench on the etch stop layer, such that the sacrificial etch segment is positioned between the first and second trenches;
- e) forming a first via hole underlying the first trench, such that the first via hole communicates with the first trench;
- f) forming a second via hole underlying the second trench, such that the second via hole communicates with the second trench, wherein: (1) the first trench and the first via hole, and (2) the second trench and the second via hole are adapted for forming a first dual damascene structure and a second dual damascene structure respectively.

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14. The method of claim 13 additionally comprising:

- a) forming the first trench at a predetermined distance D from the second trench; and
- b) forming the sacrificial etch segment at a predetermined width W, such that D exceeds W by a measure N.

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15. The method of claim 14 wherein N is at least  $0.02\mu$ .

16. The method of claim 13 wherein the etch stop layer comprises one or more dielectric materials selected from the group consisting of silicon oxides, silicon nitrides and silicon carbides.

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17. The method of claim 13 additionally comprising simultaneously filling the first and second trenches, and the first and second via holes with a conductive material, whereby first and second dual damascene structures are formed.

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18. The method of claim 17 wherein the conductive material comprises one or more materials selected from the group consisting of metals, alloys, metallic superconductors and nonmetallic superconductors.

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19. A method of forming a structure on a substrate, the method comprising:

- a) depositing a first dielectric layer on the substrate;
- b) depositing a second dielectric layer on the first dielectric layer, wherein the first and second dielectric layers comprise materials having dissimilar etching characteristics;
- c) depositing a first mask layer on the second dielectric layer wherein the first mask includes: (1) a first via pattern having a predetermined width T, (2) a second via pattern and (3) a sacrificial etch pattern positioned between the first and second via patterns such that the sacrificial etch pattern has a predetermined width W;
- d) anisotropically etching the first and second via patterns through the second dielectric layer and forming a sacrificial etch segment by simultaneously anisotropically etching the sacrificial etch pattern through the second dielectric layer;
- e) removing the first mask layer;
- f) depositing a third dielectric layer on the second dielectric layer, wherein the second and third dielectric layers comprise materials having dissimilar etching characteristics; and
- g) depositing a second mask layer on the third dielectric layer, wherein the second mask layer includes: (1) a first trench pattern overlaying the first via pattern and the third dielectric layer, and having a predetermined width P and (2) a second trench pattern overlaying the second via pattern and the third dielectric layer, and having a predetermined distance D between the first and second trench patterns wherein D exceeds W by a measure N, in which: (1) the first via pattern and the first trench pattern are adapted for forming a first dual damascene structure and (2) the second via pattern and the second trench pattern are adapted for forming a second dual damascene structure.

20. The method of claim 19 further comprising:

a) anisotropically etching the first and second trench patterns through the third dielectric layer, thereby forming a first trench and a second trench, additionally forming a third and a fourth via pattern; and

5 b) anisotropically etching the third and fourth via patterns through the first dielectric layer, thereby forming a first via hole and a second via hole.

*Sup 5*  
21. The method of claim 20 wherein a cap layer is interposed between the substrate and the first dielectric layer.

22. The method of claim 21 additionally comprising:

a) anisotropically etching the first and second trenches through the second dielectric layer; and

15 b) simultaneously anisotropically etching the first and second via holes through the cap layer.

23. The method of claim 19 wherein the first and third dielectric layers comprise materials having similar etching characteristics.

*20 SUB C7* 24. The method of claim 19 wherein N is at least  $0.02\mu$ .

25 25. The method of claim 19 wherein the first and third dielectric layers comprise one or more dielectric materials selected from the group consisting of amorphous fluorinated carbon, organic spin-on materials, spin-on glass, aero-gel, poly(arylene) ethers, fluorinated poly(arylene) ethers and divinyl siloxane benzocyclobutane.

30 26. The method of claim 25 wherein the second dielectric layer comprises one or more dielectric materials selected from the group consisting of silicon oxides, silicon nitrides and silicon carbides.

27. The method of claim 19 wherein the first and third dielectric layers comprise Black Diamond™.

28. The method of claim 19 wherein depositing a first mask layer comprises depositing a mask layer selected from the group consisting of photoresist mask layers, hard mask layers and combinations of photoresist mask layers and hard mask layers.

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29. The method of claim 20 additionally comprising simultaneously filling: (1) the first trench and the first via hole, and (2) the second trench and the second via hole with a conductive material, whereby first and second dual damascene structures are formed.

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30. The method of claim 29 wherein the conductive material comprises one or more materials selected from the group consisting of metals, alloys, metallic superconductors and nonmetallic superconductors.

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31. The method of claim 19 wherein T exceeds P by a predetermined measure M.

32. The method of claim 31 wherein M is at least  $0.02\mu$ .

33. A method of forming a structure on a substrate, the method comprising:

a) depositing a first dielectric layer on a substrate;

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b) depositing a second dielectric layer on the first dielectric layer, wherein the first and second dielectric layers comprise materials having dissimilar etching characteristics;

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c) depositing a third dielectric layer on the second dielectric layer, wherein the second and third dielectric layers comprise materials having dissimilar etching characteristics and wherein the first and third dielectric layers comprise materials having similar etching characteristics;

d) depositing a hard mask layer on the third dielectric layer, wherein the second dielectric layer and the hard mask layer comprise materials having similar etching characteristics;

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e) depositing a first photoresist layer including a first via pattern having a predetermined width X on the hard mask layer;

f) anisotropically etching the first via pattern through the hard mask layer;

g) removing the first photoresist layer from the hard mask layer; and

h) depositing a second photoresist layer including a trench pattern, having a predetermined width Y such that X exceeds Y by a predetermined measure Z, overlaying the via pattern on the hard mask layer and forming a second via pattern, whereby the trench pattern and the second via pattern are adapted for forming a dual damascene structure.

34. The method of claim 33 further comprising:

a) anisotropically etching the second via pattern through the third dielectric layer;

b) anisotropically etching the trench pattern through the hard mask layer and simultaneously anisotropically etching the second via pattern through the second dielectric layer; and

c) anisotropically etching the trench pattern through the third dielectric layer thereby forming a trench and simultaneously etching the second via pattern through the first dielectric layer thereby forming a via hole.

35. The method of claim 33 wherein Z is at least  $0.02\mu$ .

36. The method of claim 33 wherein the first and third dielectric layers comprise one or more dielectric materials selected from the group consisting of amorphous fluorinated carbon, organic spin-on materials, spin-on glass, aero-gel, poly(arylene) ethers, fluorinated poly(arylene) ethers and divinyl siloxane benzocyclobutane.

37. The method of claim 36 wherein the second dielectric layer comprises one or more dielectric materials selected from the group consisting of silicon oxides, silicon nitrides and silicon carbides.

38. The method of claim 33 wherein the first and third dielectric layers comprise Black Diamond™.

39. The method of claim 34 additionally comprising simultaneously filling the trench and the via hole with a conductive material, whereby a dual damascene structure is formed.

40. The method of claim 39 wherein the conductive material comprises one or more materials selected from the group consisting of metals, alloys, metallic superconductors and nonmetallic superconductors.

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41. A device comprising:

- a) a dielectric stack comprising a plurality of dielectric layers including an etch stop layer;
- b) a first region in the stack defining a first trench positioned on the etch stop layer;
- c) a second region in the stack defining a second trench positioned on the etch stop layer;
- d) a third region in the stack contacting the first trench and defining a first via hole underlying the first trench;
- e) a fourth region in the stack contacting the second trench and defining a second via hole underlying the second trench; and
- f) a sacrificial etch segment in the etch stop layer positioned between the first and second trenches, wherein: (1) the first trench and first via hole, and (2) the second trench and the second via hole are adapted for forming a first dual damascene structure and a second dual damascene structure.

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42. An apparatus for controlling the formation of a fabricated structure on a substrate, the apparatus comprising:

- a) at least one controller adapted for interacting with a plurality of fabrication stations including: (1) a first fabrication station for forming a dielectric stack including an etch stop layer; (2) a second fabrication station for forming a sacrificial etch segment in the etch stop layer, (3) a third fabrication station for forming a first trench on the etch stop layer, (4) a fourth fabrication station for forming a second trench on the etch stop layer, (5) a fifth fabrication station for forming a first via hole underlying the first trench and (6) a sixth fabrication station for forming a second via hole underlying the second trench, and

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- b) a data structure which causes the controller to control the formation of the fabricated structure.